JOHN WEISS

A NEW SCOTOMETER

By Col. R. H. Elliot, I.M.S.

PARTICULARS ON APPLICATION

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COMMUNICATIONS

TONOMETRY

BY
HJ. SCHIÖTZ,
CHRISTIANIA.

A PREVIOUS article by the present writer, on "Tonometry," which was published in the *Archiv für Augenheilk.*, Vol. LXVIII., Part 1, p. 77, is already some years old. Although during these years I have never quite ceased to occupy myself with the tonometer, I have not until the last three or four years been able to turn my full attention to a close investigation of the subject. My aim is partly to improve the instrument, if possible, partly to extend our knowledge of the mode of action of the tonometer, and partly to check and correct the curves, the construction of which I based on not more than eight enucleated eyes.

With regard to the last problem, a highly esteemed colleague, Mr. Priestley Smith, of Birmingham, has forestalled me. In his treatise "On the Limitations of the Tonometer,"* he published the results of a series of very minute tonometric and manometric measurements of dead eyes *in situ*, showing that my measurements of enucleated eyes gave undoubtedly too low values, evidently because the bulb and cornea became more rigid after enucleation than they are in their natural surroundings in the orbit. I will discuss these measurements later, but will merely remark here that I did not consider the values which I found at that time to be final.

In other respects I fully agree with Mr. Priestley Smith in every one of his statements concerning the tonometer and its application. As pointed out by him, his conclusions on the whole bear out my own. I understood his article to be, to use his own words, "not an attack on the Schiötz tonometer, but rather a defence."

Immediately after the appearance of my tonometer the objection was put forward from various quarters that the weight had to be

* *Ophthalmic Review*, 1915, p. 65.

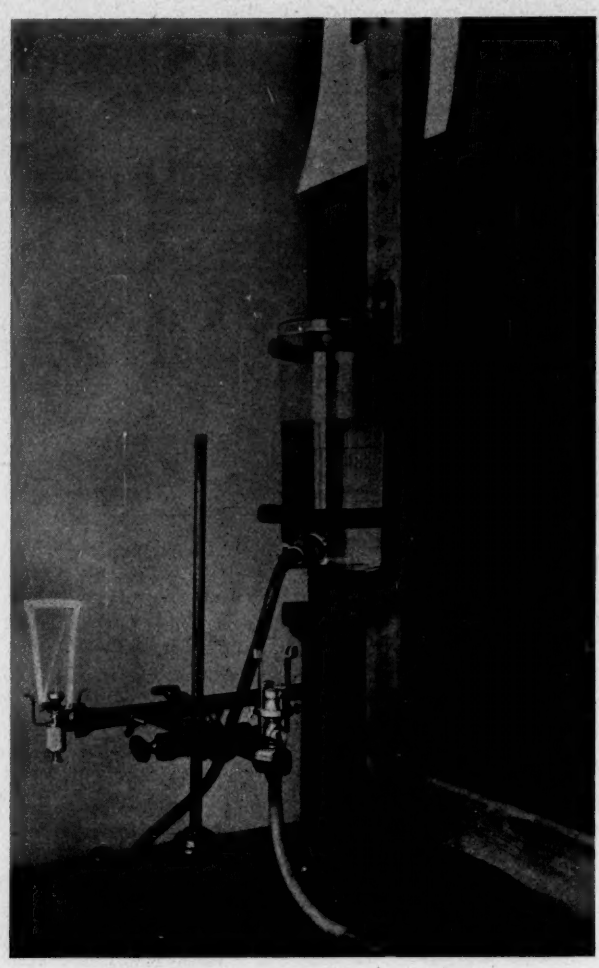

FIG. 1.

unscrewed from the plunger when another weight was needed. My esteemed colleague, now deceased, Dr. Marple, of New York, made several statements on this point. After working at the problem for a considerable time, I have now constructed a new model (Fig. 1) in which the plungers and weight form one piece, which may be put into the cylinder from above. If a heavier weight is needed, another weight may be placed on top of the first one. The new

model has not yet been fully tested by experiment, and I do not know whether it will prove as reliable with regard to its measurements as the original. I hope that it will be obtainable before long at Jacobsen's Elektriske Verksted, Christiania, for comparison with the old one.

In my experiments I employed, besides eyes, a small hollow metal cylinder or drum of 14 mm. diameter. It is closed above by a thin rubber membrane, below by a tap, by means of which its connection with the manometer may be opened or closed. As a manometer I used an irrigator hung on a stand or wall; it can be raised by 5 or 10 cm. at a time.

The Plunger

During my experiments I became aware of the extraordinary influence of the shape of the lower end of the plunger on the extent of the deflections of the pointer. In my tonometer the lower end of the plunger is concave, and the radius of curvature is the same as that of the concave surface of the base, viz., 15 mm. For technical reasons the question was raised whether the lower end of the plunger should be made flat. I found, however, that with a flat plunger the deflections were considerably greater than with a concave plunger under the same pressure, and a still greater difference was found with a convex plunger. I may state, further, that with one "flat" plunger the difference was relatively slight, while with another it was considerable; I found that the former was in reality slightly concave, and the latter, perhaps, a trifle convex.

TABLE I

Weight 5·5 grm.

Deflections of the pointer in mm.

Pressure H_2O.	Concave Plunger.		Convex Plunger.	
	Open.	Closed.	Open.	Closed.
5 cm.		11 mm.		19·3 mm.
10 ,, ...		7·5 ,,		16 ,,
20 ,, ...	14 mm.	4·3 ,,		11·5 ,,
30 ,, ...	6 ,,	3 ,,	15·2 mm.	8·5 ,,
40 ,, ...	3·5 ,,	1·7 ,,	10·7 ,,	6·3 ,,
50 ,, ...	2·3 ,,	1 ,,	7·5 ,,	5 ,,
60 ,, ...	1·5 ,,	0·4 ,,	6 ,,	4·2 ,,
70 ,, ...	<1 ,,	0 ,,	4·9 ,,	3·5 ,,
80 ,, ...	0·3 ,,		4 ,,	3 ,,
90 ,, ...	0 ,,		3·2 ,,	2·3 ,,
100 ,, ...			2·6 ,,	2 ,,
110 ,, ...			2 + ,,	1·6 ,,
120 ,, ...			1·6 ,,	1·05 ,,

Table 1 shows the deflections obtained under weight of 5·5

grammes, with a concave and a very convex plunger respectively, the drum being covered with a double rubber membrane, each layer of which was 0·133 mm. thick.

It will be seen that under the lower pressures the deflections given by the two plungers differ by as much as 8 mm. Under higher pressures the difference decreases, but while zero was reached with a water pressure of 80-90 cm. in the one case, a deflection of 16 mm. still occurred even at a water pressure of 120 cm. in the other, and the zero was still far off, for pressure-increments of 10 cm. here would soon be represented by quite minimum variations in the deflections.

The influence of the shape of the plunger-end came as a complete surprise to me, but it may be explained in the following way:

When a concave plunger rests on a correspondingly curved membrane, and the upward pressure against the small area of membrane which is in contact with the plunger equals the weight of the plunger, the plunger is counter-balanced—assuming that the membrane itself exercises no resistance. Thus the plunger with its adjuncts weighs 5·5 grm., and its end has a diameter of 3 mm., giving an area of nearly 7 sq. mm. This area of 7 sq. mm. bears a weight of 5·5 grm., or approximately 0·8 grm. per sq. mm. It must, therefore, be balanced by an upward pressure of 0·8 grm. per sq. mm., or 80 grm. per sq. cm., i.e., by a water-column of 80 cm. This is fairly accordant with the experiments (Table 1 concave plunger, communication with drum open). In like manner a plunger having an end-surface of only 1 sq. mm. and the same weight as before, would require an upward pressure of 5.5 grm. against this area as a counterbalance, i.e., a water column of 550 cm.

When the plunger presses the membrane downwards, it carries down not only the small portion with which it is in contact, but more or less of the surrounding membrane also. These together form the supporting area for the plunger. The plunger comes to rest when the upward pressure against this area equals the downward pressure, i.e., the weight of the plunger.

We can find the extent of the supporting area (A) by dividing the weight of the plunger by the water-pressure per sq. mm. which is found to counterbalance it. For example, the concave plunger, when giving a deflection of 6 mm. (Table 1) was balanced by an upward water-pressure of 0·3 grm. per sq. mm.; whereas the convex plunger, when giving the same deflection, was balanced by a water-pressure of 0·6 grm. per sq. mm. The supporting areas in the two cases are then as follows:

$$\text{For the concave plunger } A = \frac{5{\cdot}5}{0{\cdot}3} = 18{\cdot}3 \text{ sq. mm.}$$

$$\text{For the convex plunger } A = \frac{5{\cdot}5}{0{\cdot}6} = 9{\cdot}2 \text{ sq. mm.}$$

We see then that, with the *same weight* in each case, the concave plunger depresses a larger area of the membrane than does the convex plunger; which is the same as saying that it rests on a larger supporting area and consequently requires less upward pressure per sq. mm. to support it. We see also that with the *same water-pressure per sq. mm.* in each case, the convex plunger makes a deeper impression in the membrane than does the concave, in order to produce the same supporting area; for example, with a water-pressure of 30 cm. the convex plunger deflects the pointer 15·2 mm., whereas the concave plunger deflects it only 6 mm., the supporting area being in each case 18·3 sq. mm.

According to what is stated above, I am inclined to think that the concave plunger is the best because, with high pressures, it gives variations of deflection that are sufficiently distinguishable right down to zero. The flat plunger is undesirable because a slight error either towards convexity or concavity causes perceptible variation in the deflections. In the case of the convex plunger the deflections are strongly influenced by slight variation in the degree of curvature. It is true that with the convex plunger, since it acts on a wider range of manometer-pressures, the heavier weights might, perhaps, be avoided, but the small and decreasing intervals in the deflections in the case of high pressures would, I think, endanger the exactitude of the results. In any case, whatever shape be adopted, it is clear that the deflections given by different tonometers will not be comparable if the plungers are differently shaped.

The Weight of the Tonometer

The weight of the tonometer is represented by two distinct parts acting independently. The one consists of the cylinder with its cup-shaped base, together with the loop carrying the flat strip and the graduated arc. This part of the tonometer, as used at present, weighs 10·1 grm. The other part consists of the plunger with its loose weight together with the pointer. The weight of this part varies with the loose weight employed: it is 5·5, 7.5, 10, or 15 grms. respectively.

The weight of the cylinder part of the instrument is of no importance as long as there is free connection between the testing drum described above (or the eye) and the manometer; with a given water-pressure the same deflection of the pointer is obtained whether the graduated arc be loaded with a weight of 10, 20, or 30 grms. It is otherwise when the communication between the drum (or the eye) and the manometer is closed. In that case the weight of the cylinder part is of the utmost importance because of the rise of pressure occurring in the drum (or eye) when the tonometer is placed upon it (see Table II).

TABLE II

Water pressure at beginning of experiment.

Deflections of the pointer in mm.

Weights attached to graduated arc.	0 cm.	20 cm.	40 cm.	60 cm.
0 grammes	18 mm.	5·5 mm.	2·1 mm.	1 mm.
10 ,, ...	11 ,,	3·5 ,,	1·5 ,,	0·8 ,,
20 ,, ...	6·5 ,,	2 ,,	0·9 ,,	0·4 ,,
30 ,, ...	2·5 ,,	1·3 ,,	0·5 ,,	0 ,,
40 ,, ...	1 ,,	0·3 ,,	0 ,,	—
50 ,, ...	0·5 ,,	0 ,,	—	—
60 ,, ...	0 ,,	—	—	—

At the commencement of the experiment the water-pressure is 0 (column 1), i.e., the fluid in the manometer is level with the rubber membrane. Then the connection is shut off and the tonometer with the 5.5 grm. weight on the plunger is placed on the membrane; the pointer is deflected 18 mm. Now weights are placed on the graduated arc and the increasing weight causes decreasing deflection exactly as when the connection is open and the manometer is raised. With a weight of 60 grm. on the arc the pointer moves past the zero line. The pressure in the drum is now due to the weight of the tonometer proper, viz., 15.5 grm. plus the added weight of 60 grm. totalling 75.5 grm. This weight rests on the lower surfaces of the base and plunger, an area of about 84 sq. mm., The pressure below the membrane, therefore, in order to counterbalance the loaded tonometer must be 75/84 or 0.9 grm. per sq. mm., a value corresponding exactly with the pressure giving nil deflection in Table 1, viz., 90 cm.

It will be seen that when the initial water-pressure is 20 cm. (column 2), and the communication is shut off, zero is reached when the arc is loaded with 50 grm. With an initial pressure of 40 cm. it is reached with a load of 40 grm., and with an initial pressure of 60 it is reached with a load of rather less than 30 grm. In the first of these cases, when the pointer stands at 0, the loaded tonometer has a weight of 65.5 grm., and rests on an area of about 84 sq. mm. This will produce inside the drum a pressure of $65{\cdot}5/84 = 0{\cdot}75$ grm. per sq. mm., i.e., a water-column of 75 cm. If the initial pressure of 20 cm. H_2O is added the total amounts to 95 cm. H_2O.

In the same way we find in the two last cases (column 3 and 4) respectively 106 cm. H_2O and 114 cm. H_2O. The last value especially is much too high, but this experiment does not claim to be very exact and the value given must be considered as approximate, the purpose of the experiment being chiefly a demonstration of the action of

the instrument and of the importance of the weight of the tonometer.

The influence of the weight of the tonometer is most clearly seen when one works with the communication between manometer and drum alternately open and closed. The following deflections were obtained when working with a weight of 5·5 grm. on the plunger and a thin rubber membrane (0·133 m.m.) on the drum.

TABLE III

Deflections in mm.

Pressure H_2O.	Open.	Shut.
5 cm.	—	14 mm.
10 ,, ...	—	10 ,,
20 ,, ...	16·5 mm.	5·8 ,,
30 ,, ...	8 ,,	3.4 ,,
40 ,, ...	4·3 ,,	2 ,,
50 ,, ...	2·55 ,,	1·1 ,,
60 ,, ...	1·5 ,,	0·75 ,,
70 ,, ...	0·8 ,,	0·1 ,,
80 ,, ...	0·3 ,,	0 ,,
90 ,, ...	0	(The membrane is considerably inflated.)

[1] I would ask those readers who are interested in the tonometer to work out graphs according to the values given in the tables; many facts will then appear more clearly than from a mere study of the tables.

If the tonometer is placed on the drum while the latter is in open connection with the manometer, and the water pressure stands at a height of 30 cm., the pointer will show a deflection of 8 mm. Now let the tonometer be removed and a little later let the connection with the manometer be closed. The pressure in the drum will be the same as before; it will still correspond with a water-column of 30 cm.; but when the tonometer is once more placed on the membrane the deflection is only 3.4 mm., an amount which, when the connection is open, corresponds with a water-column of 45 cm. The increase in pressure can only be due to the weight of the tonometer.

If graphs are worked out according to the values given in Table III, for the open and the closed drum respectively, it will be seen that the difference between them at the lowest pressure amounts to nearly 17 cm., decreasing at higher pressures to about 12 cm. at zero, i.e., when the pointer stands at the first line, or when no deflection is obtained. At a water pressure of 73 cm. the tonometer still gives a deflection of 0·6 mm., but when, after the removal of the tonometer, the connection with the drum is closed, and the tonometer replaced on the membrane, the pointer stands at zero.

While the tonometer rests on the membrane the water pressure in the drum apparatus has risen to 85 cm., i.e., the pressure which brings the pointer to zero when the communication is open.

In the case before us, where the plunger in both circumstances is pushed completely up, it is only the cylinder part of the tonometer which causes the difference in pressure between the open and the closed cylinder. The cylinder part weighs 10 grm. and rests on a supporting area of 76 sq. mm., viz., the whole surface of the tonometer, 84 sq. mm., minus the under surface of the plunger, 7 sq. mm., or, as the whole is a fraction larger, 8 sq. mm. Every square millimetre therefore bears a pressure of 10/76 or 0·13 grm. The pressure of the cylinder part of the instrument will produce a corresponding pressure inside the drum of 0·13 grm. per sq. mm., or 13 grm. per sq. cm., which corresponds to a rise of the manometer of 13 cm.; this agrees approximately with the value found, viz., 12 cm. The zero point is not easily determined by means of a rubber membrane.

At lower pressures complications arise with regard to what is due to the weight of the plunger part, and what to the cylinder part. At all events the difference must be dependent on the weight of the whole tonometer (15·5 grm. in our case), which rests on the supporting area of 84 sq. mm.; each square mm. is subject therefore to a pressure of (15·5/84) 0·185 grm., causing in its turn, an equal increase of pressure in the cylinder, and corresponding to a rise of the manometer of 18·5 cm., which is fairly concordant with the difference of 17 cm., found between the curves.

In my paper "Tonometrie" (*Archiv f. Augenheilk.*, Vol. LXII, Part iv, 1909, p. 319), I pointed out this difference between the graphs of the open and the closed eye, but the values given there for the difference were much too high, especially for the higher weights at low pressures; thus for 5·5 grm. it was 20 cm., for 7·5 grm., 26 cm.; for 10 grm. 31·5 cm.; and for 15 grm., 43 cm., while the correct values, according to computation, should be respectively 19 cm., 21 cm., 24 cm. and 30 cm.

According to my latest measurements, taken as recommended by Priestley Smith, the difference between graphs of the open and the closed eye is much less, at least for the weight of 5.5 grm., viz., at low pressures 1.55 cm. and at zero only 10.5 cm.

I used to imagine the probable existence of an invariable proportion petween the graphs of the open and the closed eye, and also that the graphs might be checked and corrected thereby. A series of experiments recently finished, however, proves clearly that no such invariable proportion is to be found.

The extent of the deflections, and with them the shape and the conditions of the graphs, are dependent on two factors, apart of course from variations in the parts of the tonometer itself, viz.,

(1) the nature of the walls in the vessel (the eye) and (2) the nature of the membrane supporting the tonometer. The following experiments illustrate this statement:

In order to have always the same membrane, I employed in all my experiments a small metal drum having a volume of 1·4 cc., covered by a rubber membrane 0·133 mm. in thickness. In the present experiments, instead of connecting the drum directly with the rubber tube of the manometer, I interposed a glass bulb having a volume of a little more than 250 cc. This bulb was immediately continuous with the drum, on the one hand, and was connected by a glass tube and tap with the rubber tube of the manometer, on the other.

The method was as follows.—After raising the manometer to the height required, the tap of the drum was closed. The tonometer was then placed on the membrane and in the supports belonging to the apparatus (see Fig. 1), in such a way as to keep it immovable during the experiment. The deflection of the pointer was noted. Then the tap on the manometer side of the glass bulb was closed, and the tap between the drum and the glass bulb was opened. When the small volume of 1·4 c.c. was thus connected with the large volume of 250 cc., there was practically no variation in the deflection of the pointer; at the very lowest pressures the index made a very slight movement of 1 mm. at the outside, and even this was usually only obtained by a slight shaking or tapping of the table. At pressures of 50 cm. and upwards, no movement on the part of the pointer was discernible, as is seen from Table IV. Identical results were obtained with a weight of 15 grm.

TABLE IV

Pressure H_2O.	Drum closed.	Drum + Bulb closed.	All open.
5 cm.	14·6 mm.	15·5 mm.	—
10 ,, ...	10·2 ,,	10·7 ,,	—
20 ,, ...	5·5 ,,	5·8 ,,	17·5 mm.
30 ,, ...	3·4 ,,	3·55 ,,	7·7 ,,
40 ,, ...	2·2 ,,	2·3 ,,	4·2 ,,
50 ,, ...	1·6 ,,	1.6 ,,	2·8 ,,
60 ,, ...	1·1 ,,	1·1 ,,	1·85 ,,
70 ,, ...	0·6 ,,	0·6 ,,	1·2 ,,
80 ,, ...	0·3 ,,	0·3 ,,	0·7 ,,
90 ,, ...	0 ,,	0 ,,	0·4 ,,
The membrane is over-distended.			

In the next experiment the glass bulb was replaced by a thin sausage-shaped rubber bag 10 cm. long, 1·5 cm. in diameter, and with a volume of about 17 c.c. In the same order as before, the tap of the drum was closed, the tonometer was placed on the

membrane and the deflection was noted. Then the tap between the rubber bag and the manometer was closed, and the tap between the drum and the rubber bag was opened. ***At this moment the pointer was deflected and gave the same deflection as when there was oben connection with the manometer.*** Frequently it was necessary to tap the table slightly in order to obtain the last fraction of a millimetre. Even at a pressure of 40 cm. the rubber bag was over-distended, and it should be noted that with an open connection and a water pressure of 40 cm. which the walls could no longer withstand, the deflections were considerably wider than with a pressure of 30 cm.

The rubber bag was then swathed in strips of gauze. The water pressure could now be increased up to 70 cm., but at this point parts of the bag were over-distended and the same phenomenon occurred; the tonometer registered a lower pressure than the manometer. With water-pressure under 70 cm., and with open communication between drum and rubber bag, the deflections were always the same as with open communication with the manometer.

A piece of a rubber glove was then tied round the bag in the whole of its length. The deflection now did not quite reach the full value given by the open drum, but it was still considerable, as will be seen from Table V.

Finally, a rubber tube 11 cm. in length, 7·5 mm. in diameter, and about 2·5 c.c. in volume was inserted in the place of the rubber bag. The deflections were considerably nearer to those obtained with the closed drum. Table V. shows the deflections obtained respectively with the various elastic-walled vessels.

TABLE V

Deflections in mm.

Pressure H_2O.	Drum open.	Drum + Bag closed.	Drum + Bag swathed, closed.	Drum + Tube closed.	Drum only closed.
5	—	—	—	18·7	15·2
10	—	—	—	13·5	10·8
20	18·5	18·5	15	7·1	5·8
30	8	8	7	4·1	3·7
40	4·2	4·3	3·8	2·5	2·2
50	2·5	2·5	—	1·6	1·4
60	1·6	1·6	—	1·1	1 +
70	1·1	over-distended.	—	0·75	0·7

(To be concluded.)

THE REFRACTION IN BUPHTHALMIA

BY

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IT is a well-known fact that, in spite of the great enlargement of the eyeball in buphthalmia, the eye is not nearly so myopic as its abnormal axial elongation would suggest. The chief factors counteracting axial myopia are:—(1) The flattening of the cornea; (2) the flattening of the lens; and (3) the displacement backwards of the lens.

(1) *The flattening of the cornea.*—The displacement forwards of the cornea, leading to the characteristically deep anterior chamber, is due to stretching of the corneo-scleral junction, so that the peripheral parts of the cornea become usually much thinned relatively to the central part. Owing, however, to the general enlargement of the globe the diameter of the cornea becomes increased, so that the cornea is flattened, and its curvature approximates nearly to that of the sclerotic. Instead of the normal radius of curvature, 7.8 mm., Gros found that the radius is about 11.8 mm.

(2) *The flattening of the lens.*—Owing to the stretching of the walls of the globe the ciliary ring, *i.e.*, the circumcorneal scleral ring over the ciliary body, becomes increased in diameter, just as it does in a case of anterior staphyloma. The suspensory ligament is thus abnormally stretched and the lens is flattened, also in exactly the same manner as in a case of anterior staphyloma. As a result the thickness of the lens in the antero-posterior measurement is diminished, and the radii of curvatures of the anterior and posterior surfaces are lengthened. There are no accurate measurements of the lens on record, but we shall not be far wrong in taking the average thickness to be reduced from 4 mm. to 3 mm. and the radii of curvature of the anterior and posterior surfaces to be increased from 9.51 mm. and 5·87 mm. to 11 mm. and 7 mm. respectively.

(3) *The displacement backwards of the lens.*—In most cases there is a slight real displacement backwards of the suspensory ligament relative to its normal attachment to the ciliary body. This is due to the enlargement of the globe and expansion of the scleral ring. Relative to the anterior surface of the cornea there is an enormous displacement backwards. Presuming the thickness of the central part of the cornea to be 1 mm. in both the normal and buphthalmic eye the distances from the anterior surface of the cornea to the anterior surface of the lens are respectively 3·78 mm. and 7·3 mm. (mean of 10 cases, Gros).

It has occurred to me that it would be interesting to obtain some definite numerical estimates of the effect of these various factors.

I have therefore calculated the cardinal points of an average buphthalmic eye. The calculations look formidable and involve some tedious arithmetic, but are really quite simple, involving only the repeated application of a few formulae.

The data are set out in the following table, in which the normal measurements are also stated for comparison.

	Normal Eye.	*Buphthalmic Eye.*
Radii of curvature :—		
Cornea	+ 7.80 mm.	+ 11.8 mm.
Ant. surface of lens ...	+ 9.51 mm.	+ 11.0 mm.
Post. surface of lens ...	— 5.87 mm.	— 7.0 mm.
Distance between ant. surface of cornea and ant. surface of lens, *i.e.*, thickness of cornea + depth of anterior chamber	3.78 mm.	7.3 mm.
Distance between ant. and post. surface of lens ...	4.0 mm.	3.0 mm.
Indices of Refraction :—		
Air		1.0000
Cornea, aqueous, and vitreous...		1.3465
Total index of refraction of lens		1.4545

In the above table and throughout the calculations the usual convention as to signs is used, *i.e.*, measurements in the direction of the incident light are +, those in the opposite direction —.

A. Systems of Two Media

The formulae for the determination of the focal lengths of systems of two media are

$$f = \frac{n\,r}{n^1 - n} \qquad f^1 = \frac{n^1 r}{n^1 - n}$$

where f, f^1 are the first and second focal lengths respectively, n, n^1 the indices of refraction of the first and second media, and r the radius of curvature of the surface.

1. Air and Aqueous Humour.

$$f = -\frac{1 \times 11.80}{1.3465 - 1} = -34.0545 \text{ mm. } (-22.5108 \text{ mm.})$$

$$f^1 = +\frac{1.3465 \times 11.80}{1,3465 - 1} = +45.8548 \text{ mm. } (+30.3108 \text{ mm.})$$

Therefore the anterior focal length of the buphthalmic cornea is 34.0545 mm. in front of the apex of the cornea, and the posterior focal length is 45.8548 mm. behind the apex of the cornea. The corresponding normal measurements are given in brackets.

2. Aqueous and Anterior Surface of Lens.

$$f = -\frac{1.3465 \times 11}{1.4545 - 1.3465} = -137.1436 \text{ mm. } (-118.5668 \text{ mm.})$$

$$f^1 + \frac{1.4545 \times 11}{1.4545 - 1.3465} = +148.1436 \text{ mm. } (+128.0767 \text{ mm.})$$

The distance of the first focal point from the apex of the cornea is

$$7.3 - 137.1436 = -129.8436 \text{ mm. } (-114.7868 \text{ mm.})$$

and of the second focal point

$$7.3 + 148.1436 = +155.4436 \text{ mm. } (+131.8567 \text{ mm.})$$

3. Posterior Surface of Lens and Vitreous.

$$f = -\frac{1.4545 \times (-7)}{1.3465 - 1.4545} = -94.2731 \text{ mm. } (-79.0545 \text{ mm.})$$

$$f^1 = +\frac{1.3465 \times 7}{1.4545 - 1.3465} = +87.2731 \text{ mm. } (+73.1848 \text{ mm.})$$

The distance of the first focal point from the apex of the cornea is

$$7.3 + 3 - 94.2731 \text{ mm.} = -83.9731 \text{ mm. } (-71.2748 \text{ mm.})$$

and of the second focal point

$$7.3 + 3 + 87.2731 = +97.5731 \text{ mm. } (+80.9648 \text{ mm.}).$$

B. Combination A 2 and A 3

The formulae for determining the focal lengths (f, f^1) of the system compounded of two other systems whose focal lengths are respectively f_1, f^1_1, and f_2, f^1_2 are—

$$F_1\ F = \frac{f_1\ f^1_1}{D} \qquad F^1_2\ F^1 = -\frac{f_2\ f^1_2}{D}$$

$$f = \frac{f_1\ f_2}{D} \qquad f^1 = -\frac{f^1_1\ f^1_2}{D}$$

where F_1 F is the distance between the first focus of the first system and the focus of the combined systems, F^1_2, F^1 is the distance between the second focus of the second system and the second focus of the combined systems, and D is the distance F^1_1 F_2, i.e., between the second focus of the first and the first focus of the second system.

In the buphthalmic eye—

$$D = -83.9731 - 155.4436 = -239.4167 \text{ mm.}$$

$$F_1, F - \frac{-137.1436 \times 148.1436}{-239.4167} = +84.8558 \text{ mm.}$$

Therefore the distance of the first focal point from the apex of the cornea

$$= -129.8436 + 84.8558 = -44.9878 \text{ mm.}$$

$$F^1_2\ F^1 = \frac{-94.2731 \times 87.2731}{-239.4167} = -34.3624 \text{ mm.}$$

FIG 1.

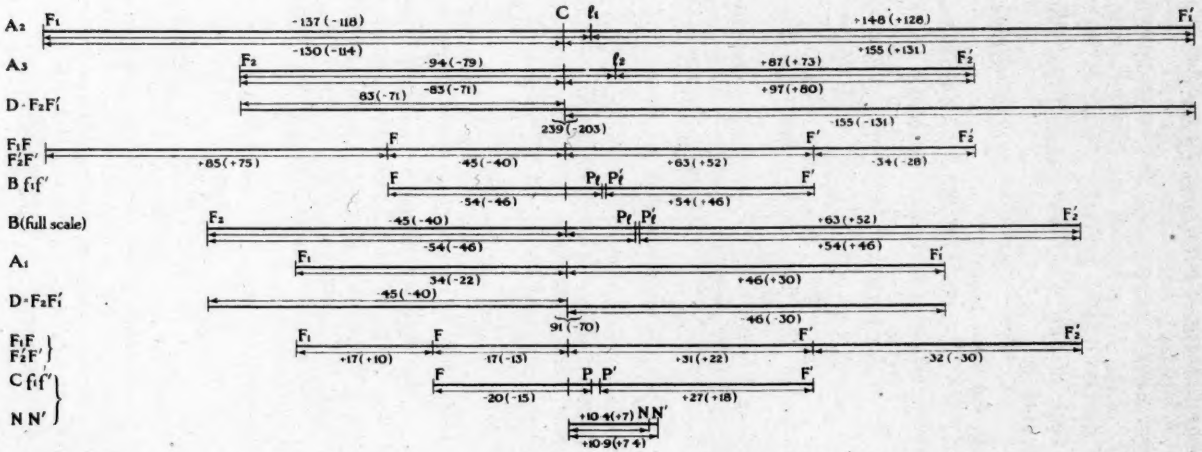

FIG. 1.—C, apex of cornea. l_1, anterior surface of lens. l_2, posterior surface of lens. P_1, P'_1, anterior and posterior principal planes of lens. P, P', principal planes of eye. N, N', nodal planes of eye. The first five measurements are on half the scale of the remainder.

Therefore the distance of the second focal point from the apex of the cornea

$$= +97.5731 - 34.3624 = +63.2107 \text{ mm.}$$

$$f = \frac{-137.1436 \times (-94.2731)}{-239.4167} = -54 \text{ mm.} (-46.1438 \text{ mm.})$$

$$f' = \frac{-148.1436 \times 87.2731}{-239.4167} = +54 \text{ mm. } (+46.1438 \text{ mm.})$$

C. Combination of B with A 1

$$D = -44.9878 - 45.8548 = -90.8426 \text{ mm.}$$

$$F_1 F = \frac{-34.0545 \times 45.8548}{-90.8426} = +17.1856 \text{ mm.}$$

$$F_2' F' = \frac{(54)^2}{90.8426} = -32.0892 \text{ mm.}$$

$$f = \frac{-34.0545 \times (-54)}{-90.8426} = -20.2403 \text{ mm. } (-14.7673 \text{ mm.})$$

$$f' = \frac{-45.8548 \times 54}{-90.8426} = +27.2546 \text{ mm. } (+19.8843 \text{ mm.})$$

The cardinal points of the buphthalmic eye, measured from the apex of the cornea, are therefore:

First focal point = - 34.0545 + 17.1856 = −16.8689 mm. (−12.8095 mm.)
Second focal point = + 63.2107 - 32.0892 = + 31.1215 mm. (+22.2119 mm.)
First principal point = - 16.8689 + 20.2403 = + 3.3714 mm (+1.9578 mm.)
Second principal point = + 31.1215 - 27.2546 = + 3.8669 mm. (+2.3276 mm.)
First nodal point = - 16.8689 + 27.2546 = + 10.3857 mm. (+7.0748 mm.)
Second nodal point = + 31.1215 - 20.2403 = + 10.8812 mm. (+7.446 mm.)
The distance between the principal points = the distance between the nodal points =0.4955 mm. (0.3698 mm.)

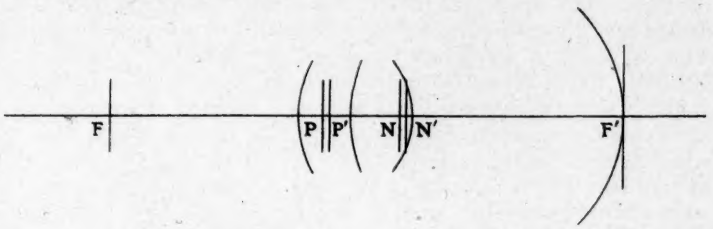

FIG. 2.—Cardinal points of the normal eye.

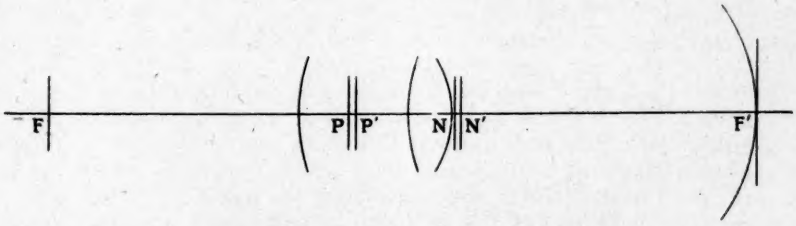

FIG. 3.—Cardinal points of the buphthalmic eye,

We see therefore that the buphthalmic eye with the average measurements chosen above would have to be 31 mm. long in order that it might be emmetropic. It is interesting to note that the *normal abhakic eye*, i.e., the aphakic eye with normal corneal curvature, must also be 31 mm. long in order that parallel incident rays may be focussed upon the retina. Such an eye, before the lens is removed, would have a myopia of (31—23) × 3 = 24 D.

E. L. Gros.—Étude sur l'hydrophthalmie ou glaucome infantile.
Ferraris' Dioptric Instruments—H.M. Stationery Office, 1919.

AN IMPROVED IRIS PROLAPSE OPERATION FOR GLAUCOMA

BY

H. HERBERT,

NOTTINGHAM.

THIS paper is supplementary to the somewhat cursory description of work done in India, published in the *Trans. Ophthal. Soc. U.K.*, Vol. XXXIX (1919), p. 218. To make the subject fully intelligible to those who do not see the *Transactions*, an outline of salient facts is included here.

The facts and arguments collected below form a reasoned plea for a fairly general utilization of the prolapse operation in this country. The appeal is timely, since many surgeons have been driven back to iridectomy by late infections following sclerectomies. This is surely a retrograde step, an unwarranted confession of failure in the professed filtration methods as a whole. Extremely valuable though iridectomy has been, it is for ever discredited as a satisfying future treatment by the fact that it fails most often (1) when most perfectly performed, and (2) where least is asked of it, in the more chronic simple glaucomas. One can never again rest content to ignore the urgent call for clinical and pathological research to explain these iridectomy results fully, and to explore the possibilities contained in them.

Method.—A purely subconjunctival sclero-corneal incision, about 6 mm. long, is made above, close to the limbus, with 1 mm. Graefe knife. The only conjunctival puncture is 3 mm. away from the limbus; from this point the conjunctiva is slid on the point of the knife. The puncture is enlarged a little when withdrawing the knife. It is quite easy to avoid wounding the conjunctiva at the counter-puncture, by beginning short sawing movements as soon as the point of the knife is seen perforating the sclera. Through this section a wide fold of iris is drawn up under the conjunctiva (see later), where it is transfixed and incised by the same narrow

knife cutting upwards. Atropin is instilled at once, two or three times, and repeated several times daily, mainly to prevent displacement of the pupil upwards.

Result.—In chronic glaucomas, however advanced, in which the rise of tension has been moderate, this has commonly been the whole treatment; the tension has remained low, and the prolapsed iris has remained flat or nearly so. The visible iris has become changed into white fibrous tissue, evidently remaining as impervious to aqueous as normal iris tissue, and forming a protective plate beneath the unchanged conjunctiva. Filtration of aqueous has developed evidently at the margin of the prolapse where the iris was incised.

It would have done so sufficiently early in most cases to prevent a return of tension, even if the iris had not been cut. The cutting has been done more particularly to prevent bulging of the prolapse.

Drawbacks.—The enlargement of the pupil is less, but the astigmatism produced generally greater than in classical iridectomy. These disadvantages are sufficient to bar the application of the method in fairly mild and early glaucomas with unimpaired central vision, which are likely to yield fully to such operations as my small flap sclerotomy (*Trans. Ophthal. Soc. U.K.*, Vol. XXX [1910] p. 199), which leave a normal pupil.

Two special drawbacks have been in evidence, particularly in the more severe advanced untreated chronic glaucomas. There has been (1) a recurrence of plus tension in three weeks or less, resisting the use of eserin and massage. Though there is reason to believe this rise of tension would have come to an end spontaneously sometime within three months, obviously we could not afford to wait for this ending. In order to preserve sight, the tension had to be kept low during this period by repeating the sub-conjunctival marginal incision of the prolapse, perhaps two or three times. The tension has then finally remained low. In somewhat earlier cases, the eyes being not so hard, there have been some slight and very transient returns of tension subsiding without supplementary incision. (2) Before, with, and after these rises of tension came more or less unsightly bulging of the prolapse. Where, as not infrequently happened, only the base of the iris had come into the wound, the elevation was correspondingly less than when the whole width of iris was included.

There was no opportunity of determining whether or in what degree some of the prominences may have remained permanently, but the tendency was to slow subsidence. In a few of my earlier cases no incision of the displaced iris was made till ten days or a fortnight after the primary operation. The early bulging was then possibly greatest in the lower grade glaucomas. Fig. 20 on p. 224 of the *Trans. Ophthal. Soc.* 1919, shows the late result of such a

case. Before the iris was cut it stretched to form a prominent sausage-shaped swelling covering the incision, and this excessive stretching may account for the imperfect sclerosis seen at the outer part of the prolapse. But the collapse brought about by one incision was complete and permanent. There was no stiffening from fibrinous deposit, such as took place apparently in the advanced higher grade glaucomas. The selection of this method may become most imperative precisely in the desperate cases in which the drawbacks are most likely to be pronounced and prolonged. But where one is struggling to preserve the little sight remaining, perhaps in one eye only, these troubles are very minor considerations.

Advantages.—If the promise shown hitherto is fulfilled later, the method has the inestimable advantage of combining certainty with safety in advanced chronic glaucoma, in a measure not hitherto approached.

(1) According to present observation, while ***lasting hypotony is never produced***, complete removal of abnormal tension is assured by these wide iris-inclusions in all primary glaucoma with any vision still remaining. (I have almost no experience of it in absolute glaucoma, and do not intend to enlarge that experience.)

In the question of *permanence*, my very long negative Indian experience may count, though it relates mainly to much smaller prolapses. In 1903 (*Trans. Ophthal. Soc.* Vol. XXXIII, p. 324) I reported on 130 iris-prolapse operations of various kinds, and since then have returned to them repeatedly in all intervals between attempts at the formation of satisfactory iris-free cicatrices. I only remember one late return of tension in the whole list of cases. In this instance the iris was particularly rigid and narrow from chronic glaucomatous changes, and the prolapse was correspondingly small.

The spontaneous ending of the recurrent tension seen after the present operation, as also of the period of tendency to such tension where the actual return of tension is mostly prevented by treatment, is strongly suggestive of permanency.

(2) Possibly there is no absolute security from the risk of disaster of vascular origin in operating in advanced chronic glaucoma. [See my two cases recorded in the *Ophthalmoscope*, Vol. XII. (1914) pp. 5-6.] But as yet the invariable absence, in these purely subconjunctival operations, of the serious accidents so much in evidence among my early Bombay iridectomies is most encouraging. Though the fields of vision were never taken, many of the eyes operated upon evidently had extremely small fields; but they did not suffer on that account.

(3) *Safety from infection, early and late.*—This crucial question must be met squarely and honestly. The time has come, and is long overdue, for discrimination among the widely varying types

and results of iris prolapse and incarceration. The old general condemnation of all alike must be rejected.

I believe that many of my Indian results were absolutely safe from ectogenous infection of all kinds. And yet these prolapses differed only in detail—all-important detail—from Bader's, found wanting in 1882 (*Trans. Ophthal. Soc. U.K.*, Vol. II, p. 127).

Taking early infections to include all such as might have taken place within the periods of continued observation practicable in our Indian hospital treatment, my extensive experience is certainly of value. This experience of prolapse both in glaucoma and cataract work, purposeful and accidental, showed clearly that early infection could be excluded by (1) effective conjunctival antisepsis before operation,* and by (2) securing a complete conjunctival covering for the prolapsed iris [see *Trans. Ophthal. Soc., U.K.*, Vol. XXIII (1903), 325 and 327; also my books on cataract extraction].

In the matter of *later* infection negative observation is of little value, particularly in India. But of recent years valuable positive knowledge of infected scars has accumulated. I have myself seen late destructive inflammation which had gained entrance through prolapsed iris, both covered and uncovered by conjunctiva. The conjunctival covering was either vesicular or defective through the formation of stomata.

In the wide prolapses now dealt with great reliance must be placed on (1) the absence of any clinically recognizable changes in the overlying conjunctiva, and on (2) the white fibrous change which takes place in the visible iris tissue. The progressive loss of colour is very striking and easily estimated in the deeply pigmented Indian iris. I have seen the whole iris surface uniformly dull grey within three months, uveal pigment being visible only at the margin, lying mostly free in the conjunctiva. Later, this grey surface becomes quite white. In this country the change may excite little notice unless steps are taken to see the final result.

In the perfect result this fibrosis is uniform and complete. The causes of irregularity in the change seem now tolerably clear, though doubtless there may be more yet to be learnt in this respect. So far as present indications go, little difficulty is likely to be experienced in securing the desired condition, except perhaps where recurrent tension is most prolonged and troublesome.

Particular care should be taken to avoid injuring this portion of iris in operating [see *Trans. Ophthal.Soc, U.K.*, (1919), p. 223]. And the formation of a *wide* prolapse is perhaps especially indicated where the tension is highest, to diffuse the filtration as much as possible. Apparently any considerable subsequent stretching of the prolapse is to be avoided [see above, p. 4, lines 14-15, and below, p. 12,

* This conjunctival antisepsis was not found commonly necessary in my latest Indian glaucoma work, and the same applies in this country.

lines 11-14]. That is to say, incision of the iris if omitted at the primary operation, should not be deferred longer than about ten days and it should be repeated afterwards immediately there is rise of tension not fully controlled by eserin and massage.

It is possible that some adhesion of the conjunctiva to the sclera, a result of former operation, may occasionally tend to produce unevenness in the elevation of the prolapse. But this should be preventable by incision of the subconjunctival tissue (see below).

When the fibrotic change in the iris is complete we have, in place of vulnerable uveal tissue, an impervious shield throughout the neighbourhood of the limbus, conducting the leaking aqueous beneath it to a wide area where the conjunctiva is free and movable, and where the only change is a diffuse oedema.

It is a complete reversal of our attitude to prolapse in general now to regard changed subconjunctival uveal tissue as an efficient safeguard against late infection, instead of as a permanent grave menace to both eyes, an unjustifiable infliction.

The prolapsed iris has been found noticeably thickened and rigid at supplementary cuttings in one or two severe glaucomas (see below, lines 9-10). Though troublesome in delaying the establishment of filtration, this thickening has perhaps a compensating advantage in affording increased protection against the penetration of surface organisms, in the very advanced cases in which this protection appears most needed, *i.e.*, where the factitious leakage needs to be greatest.

Recent utilization of the method in this country.—The first operation was performed last July in a case of severe haemorrhagic glaucoma, with considerable vitreous opacity, the result of retinal venous thrombosis. It was selected as the supreme test of the safety and efficiency of sub-conjunctival operation, presumably a more severe test than would be furnished by any primary glaucoma.

After the incision had been made nothing more could be done owing to the bleeding which took place, freer than any I have seen in primary glaucoma. Being at least partly intraocular in origin the blood carried the base of the iris into the wound. Afterwards the blood was quickly absorbed.

The first cutting of the iris was done just three weeks later, as soon as the first elevation of tension was detected; and the second incision five weeks later still. Thickening and toughening of the prolapse tissue was then very distinctly noticeable. But after another month the tension felt normal, and the vision had improved from finger counting at a few inches to the same at four feet. The case then looked most promising.

However, in view of the well recognized tendency to extension of the retinal condition, one had no right to expect such a simple ending of the case. Four and a half months after the original operation the Schiötz tension was 6 mm. higher than in the fellow eye; and the fundus, now easily seen, showed a good deal of bright red blood, with some dark blood and white patches. The patient had been working on the land, bending down.

A third sub-conjunctival incision, then made, apparently added to the trouble. Hyphaema appeared and persisted in varying amount, being evidently added to repeatedly. It was in two layers, bright above, dark below. Haemolysis appeared to be responsible for a good deal of inflammatory reaction; there was a broad band of

bright ciliary injection. The tension was slightly up again in three weeks, and in a little over six weeks it rose to + 2, with considerable pain. A small sub-conjunctival tapping of the prolapse fortunately then gave almost immediate relief. Ciliary congestion, blood, pain, and tension all quickly disappeared. When last seen, two months later, eight months from the beginning of the treatment, the eye was quiet and the tension felt normal; but there was no sight left.

The experience has been distinctly encouraging in its bearing on the treatment of primary glaucoma by this method. It seems highly probable that with an open wound of the same size, the haemorrhage at the primary operation would have been expulsive; but it was restrained sufficiently by the conjunctiva and sub-conjunctival tissue, already infiltrated by aqueous. The reduction of tension after the second cutting of the prolapse, and again, finally, was satisfactory. The incarcerated iris remained almost flat for a long time, possibly stiffened by fibrin, but it stretched and became somewhat prominent as the later tension became pronounced. The stretching was a little uneven, producing temporary unevenness in the fibrosis, but afterwards the only uveal colour visible was quite at the ends of the prolapse.

I have since performed sixteen more of these operations, and attempted the same in three additional cases, but failed to get a satisfactory iris inclusion. These operations have served to emphasize some technical points.

Some points of technique.—Whereas all my Indian operations were first operations, of these the majority had already been treated by small flap sclerotomy. Hence the conjunctiva was somewhat adherent about the middle of the new incision, though not sufficiently so to necessitate preliminary subconjunctival injection of fluid.

This moderate adhesion of the conjunctiva interfered with the drawing of the iris up through the wound. It had never hitherto been found necessary to cut up under the conjunctiva before drawing up the iris, but this was now frequently done while enlarging the conjunctival puncture.

(2) Where only a quarter per cent. eserin solution has been used in preliminary treatment, the miosis usually gives way readily to adrenalin and cocain instillation. But even where 1 per cent. eserin may have been used beforehand, it is well not to use atropin until after moderate instillation of adrenalin and cocain. The reason for this is that it is better to operate when the pupil is not widely dilated. In order to widen the prolapse it is often better not to cut the iris at all until a week or ten days after the primary operation. To keep the conjunctiva healthy for this delayed incision the eye is kept open under a shield after the first day.

(3) The iris should be well drawn up under the conjunctiva before it is incised. Otherwise it is likely to fall back into the anterior chamber after it has been cut. This tendency is increased by failure to free an adherent conjunctiva, and by rigidity of the pupil. Thus occurred the failure mentioned above. The iris returned almost entirely into the chamber, mostly after the application of the bandage. Lately, I have used very fine straight forceps for drawing up the iris. The iris is seized near its base Punctures or tears are permissible only towards the base of the iris, lest the formation of an effective subconjunctival plate be made impossible. To facilitate the introduction of the iris forceps, the conjunctival puncture is now made in a line drawn horizontally outwards from the scleral puncture.

(4) At any subsequent sub-conjunctival incision of a bulging prolapse, the same sliding of the conjunctiva is practised as at the primary operation. The cutting is made as close to the sclerotic as possible. Where the swelling is particularly prominent and rigid, the incision may sometimes be doubled in part, keeping still close to the sclerotic. Isolating a purely marginal narrow strip of the prolapse tissue thus appears unobjectionable, and may aid in the development of permanent leakage.

Preliminary Miotic Treatment

Consideration of the essentially temporary rise of tension seen after these prolapse operations* permits of a practical deduction, likely to prove of value in the general operative treatment of glaucoma. Three points claim attention:

(1) The rise is evidently largely proportionate to the suddenness, and extent of the drop in tension, and to the previous duration of the plus tension. It was most marked and lasted longest in eyes which were distinctly hard until a few days before operation, and which had been so for a considerable time, as shown by the very small remnant of sight left. Eyes with moderate or minimal elevation of tension were nearly or entirely exempt from recurrence.

(2) There was no other clinical feature to distinguish some of the eyes which provided protracted return of tension. Before operation eserin contracted the pupil fully, with complete reduction of tension, demonstrating the absence of iritic changes and of firm closure of the filtration angle.

(3) The relatively great drop from the higher degrees of chronic tension is perhaps an ample explanation, both of the subsequent rise and of its limited duration. Two assumptions seem warranted in these cases: (a) The aqueous after operation must be more highly albuminous (Treacher Collins, *Trans. Ophthal. Soc. U. K.*, 1917 and 1918) than in mild and early glaucomas; and (b) the aqueous may not become quite normal again for two months or more, where the vascular changes from the previous prolonged high tension are most profound.

The obvious deduction is that in these eyes in which eserin acted well before operation, much or all of the subsequent high tension might have been avoided by keeping the eyes normally soft for a considerable time beforehand.†

And what is true of these prolapse operations should apply more or less to other filtration operations, including to some extent iridectomy. That is to say, in the attempt to form iris-free filtering cicatrices, any measure which tends to lessen the albumen content of the aqueous, and to restrict the deposit of fibrin throughout the healing period, must aid in the desired object of preventing firm healing. And since a return of tension, indicating firm healing after these operations is essentially permanent, its prevention is much more important than after the prolapse procedure.

Hence there seems reason to lay down the rule tentatively in chronic primary glaucomas, that no eye with continuous plus

* Noted long ago, see *Trans. Ophthal. Soc. U.K.*, Vol. XXIII (1903), p. 327.

†Note the shortened period of recurrent tension in the case of the second eye reported on p. 225, *Trans. Ophthal. Soc. U. K.*, 1919, perhaps attributable in part to moderate preliminary eserin treatment.

tension which can be relieved fully by eserin, should ordinarily be operated upon without preliminary miotic treatment lasting for a period proportionate to the degree and probable duration of the tension. A period of two to three months would be the maximum, as far as it can be judged from the recurrences after operation.

Selection of Operation

The above division of chronically glaucomatous eyes into two groups, according to completeness or incompleteness of response to miotics, may be of service in indicating the type of operation suitable to individual cases.

The one group may possibly contain all the cases in which such a simple measure as flap sclerotomy may be expected to succeed. Does it include only these ? Pending further development of my thread sclerotomy (*Trans. Ophthal. Soc. U. K.*, 1919), should not some very advanced mild glaucomas, with damaged central vision, be subjected rather to the wide prolapse treatment, even though the tension may give way quite readily to eserin ?

The prolapse operation may be perhaps at present the soundest treatment for all primary glaucomas not fully reducible by eserin, and not already operated upon by wide iridectomy. Certainly, the application of the method promises to be much wider than was suggested in the *Transactions* (1919), p. 218.

For use in India I think it is the best routine general operation, suited to the capacity of the average civil surgeon.

The existence of a wide coloboma, while barring the prolapse operation, renders an eye particularly suited to thread sclerotomy. In this operation the only real difficulty lies in preventing adhesion of iris to the wound.

These three operations cover nearly the whole field of primary glaucoma, combining safety with efficiency. Together they go far towards the final solution of the main glaucoma question, which has not proved to be so simple as it once seemed to be.

THE TREATMENT OF PROLAPSE OF THE IRIS FOLLOWING ACCIDENTAL PERFORATING WOUNDS, WITH A NOTE ON THE REMOVAL OF NON-MAGNETIC FOREIGN BODIES FROM THE ANTERIOR CHAMBER *

BY

CHARLES GOULDEN, O.B.E., M.D., M.C., F.R.C.S.

PROLAPSE of the iris in connection with accidental wounds of the eye is a fairly frequent occurrence. Many cases are not difficult to

* Read in the Section of Ophthalmology of the Royal Society of Medicine on March 3rd, 1920.

deal with, but on the other hand there are cases, especially when the wound in the cornea or corneo-sclera is an extensive or irregular one, which are difficult to manage.

Individual experience, even over a long period, is never very extensive, but the numerous eye injuries that occurred during the war gave to those who were in charge of ophthalmic wards over-seas an extraordinary opportunity of dealing with, not only great numbers, but an infinite variety of wounds of the eye associated with prolapse of the uvea.

Attempts at reposition of prolapsed iris should be avoided on account of the risk of infection of the interior of the eye, and because such a procedure is useless as the reposed iris will again prolapse.

Every attempt should be made, not only to remove the piece of iris prolapsed, but also to clear the wound of uvea; if left with iris incarcerated one or other of the following undesirable conditions will follow:

(*a*) Delayed healing of the wound;
(*b*) A weak scar which may bulge before the intraocular pressure;
(*c*) Defective vision due to a displacement of the pupil and irregular refraction of the cornea;
(*d*) Iridocyclitis;
(*e*) Sympathetic iridocyclitis.

In any event, the appearance of the eye is much better with a well made iridectomy than with a distorted pupil and a leukoma adhaerens. When undertaking the removal of a prolapse of the iris a great deal depends upon the length of time that has passed since the accident and no doubt cases that come into the hands of the surgeon several days after the iris first prolapsed are very much more difficult to deal with. It is impossible to lay down a definite time after which it is impossible or not advisable to operate. Cases can certainly be operated upon and the wound freed of uvea as long as ten days after the accident. A method of operating which makes these cases more easy to deal with will be mentioned a little later on.

It will be convenient to divide the cases into groups as follow:

(1) Cases in which the wound is purely corneal,
(2) Cases in which the wound is at the corneo-scleral margin.
(3) Cases in which the wound extends past the limbus into the sclera.

If the prolapse of iris is complicated by the presence of a magnetic foreign body, this should receive attention and be removed from the eye through a separate incision before the prolapse is dealt with.

As a rule the patient requires a general anaesthetic; this will allow deliberate operating and the surgeon will be able to pull the iris in any direction he may consider necessary without feeling anxious lest the patient make some sudden movement which may lead to extensive tearing of the iris and bleeding that will hide everything that it is necessary to see so as to complete the operation properly.

1. *Cases in which the wound is purely corneal.*

If the wound be small these cases are the easiest to treat. The prolapsed knuckle of iris should be seized in toothed iris forceps, held in the right hand and the iris gently pulled in each direction,

FIG. 1.
Showing the method of using Couper's capsule forceps in seizing the prolapse of iris along its whole length. In the upper part of the cornea is shown the incision recommended for the use of the repositor in difficult cases.

from side to side, to and from the ciliary attachment, the iris within the eye being observed all the time. It is important to make certain that there is perfect freedom of the iris where it is grasped by the edges of the corneal wound. Whilst drawing gently upon the iris seize, in the plane of the anterior surface of the cornea, the whole length of the prolapse with Couper's capsule forceps (Fig. 1), release the hold with the iris forceps, and drawing gently with the Couper's forceps, cut off the iris with de Wecker's scissors, pressing them gently upon the cornea whilst cutting. This cut must be done with one snip of the scissors, as the haemorrhage which follows most likely will obscure the contents of the anterior chamber and will not allow a second attempt to be made with safety to the lens capsule. Usually the iris springs back into the anterior chamber leaving the pillars of the consequent coloboma quite free.

What has been done is, in effect, this: A portion of the iris not previously prolapsed has been drawn outside the eye, the iris has been put on the stretch, and the cut with the scissors has been made through healthy iris drawn outside the eye by the operator.

Now, wounds of the cornea are usually radial, the perforating instrument piercing the eye directly from before backwards. It is in such cases that treatment is not difficult, but when the wound of the cornea is ragged, flap-like, or tangential (like a wound made with a keratome), the problem of freeing the corneal wound completely is much more difficult. It is not difficult to free that portion of the iris that followed the path of withdrawal of the perforating instrument, as the repositor can be used by passing it into the eye in the same plane and direction in which the perforating instrument entered the eye, but the repositor, however bent or manipulated, cannot be made to engage that portion of the iris that lies under the lower lip of the valve-shaped wound, and consequently that pillar of the coloboma is often left still engaged in or adherent to the wound in the cornea.

The plan that has been used with success in such cases is as follows:

Before attempting to deal with the prolapse of iris, and whilst there is still an anterior chamber, make a small incision in the cornea at a point just opposite the accidental wound (Fig. 1), and three millimetres within the limbus; the wound need not be more than four millimetres long. Now deal with the prolapse and free it as well as possible. After this the repositor may be used by inserting it within the eye through the incision made with the keratome and the pillars of the coloboma replaced. If a foreign body has been removed previously, the incision made for its removal may be used for inserting the repositor.

The above remarks apply to a case in which operation is undertaken within twenty-four hours of the accident, and before any firm adhesions have formed between the prolapsed iris and the edges of the corneal wound. If more than a day has passed, and especially if several days have passed since the accident, the operation is much more difficult. The iris will be covered with greyish lymph and sodden with exudate where it is prolapsed and the edges of the corneal wound softened and grey with infiltration.

The lymph should be gently teased away from the iris with a repositor under a stream of warm saline solution, which will cause the prolapsed iris to be seen more easily, being washed here and there by the stream of lotion, for it must be remembered that the iris is often almost completely bleached and much attenuated. It is now seized and carefully freed. This is best done by paying attention to each part of the corneal wound in turn. Draw the prolapse away from one side, almost in the plane of the cornea, and

whilst doing this gently insert the iris repositor between the lip of the corneal wound and the iris, breaking down adhesions all the time until it is possible to pull uninjured iris from within the eye all along the edge of the wound in the cornea. This must be repeated in all directions and then the iris cut off as described above.

2. ***Cases in which the wound is at the corneo-scleral margin.***

In these cases the wound is not infrequently punctiform and although the wound will allow the iris to prolapse, it is not sufficiently large to admit the iris repositor after the iris has been removed. Here again the advantage of the preliminary corneal incision will be seen.

3. ***Cases in which the wound extends past the limbus, thus involving both cornea and sclera.***

Here the corneo-scleral wound and subsequent prolapse of iris is complicated by a wound in the conjunctiva. As the conjunctiva, lacerated or cut, falls together and soon becomes adherent by its cut edges, it is difficult to judge the extent of the wound and the amount of uvea prolapsed: hence the importance of exposing freely the corneo-scleral wound and the inadvisability of attempting an operation until the conjunctiva has been drawn quite freely to one side.

With an ordinary strabismus scissors extend the conjunctival wound, undermining if necessary, and then having passed a suture through each edge, let your assistant draw the edges apart or attach a small artery forceps to the end of each suture and allow them to retract the wound by their own weight (Fig. 2). The corneo-

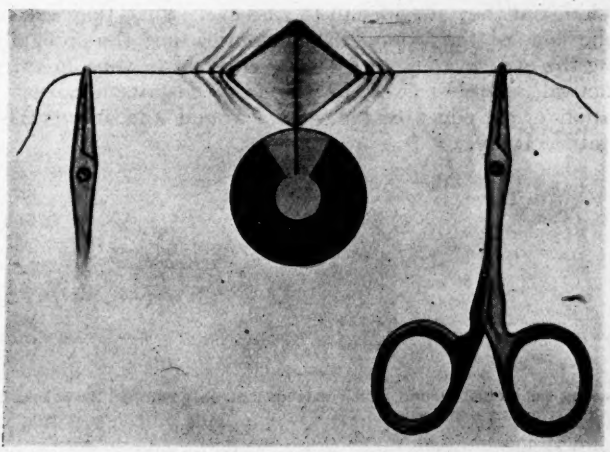

FIG. 2.

Showing the method of exposing a wound in the sclera by retracting the conjunctiva so as to deal with the uvea prolapsed.

sclera is then beautifully exposed and the prolapsed iris and ciliary body can be seen along their whole length and deliberately dealt with. It is important that such wound in the sclera should be completely covered with conjunctiva, and unless the edges of the conjunctiva fall together easily and without tension, the conjunctiva should be undermined around the scleral wound and detached from the limbus on each side by cutting round the edge of the cornea. To ensure immediate closure of the wound the conjunctiva should not be sutured edge to edge, but by two or more U-shaped sutures

FIG. 3.

Showing the method of inserting sutures in the conjunctiva after dealing with such a case as that shown in Fig. 2.

(Fig. 3) passed a little distance from the edge of the conjunctival wound. The question of the use of scleral sutures will admit of discussion, but they are difficult to pass even when they are passed from the edge of the wound to the exterior, and the probability of bruising the eye severely and losing vitreous is very great. The conjunctival suture passed in the way described causes good adaptation of the edges of the scleral wound and braces them up quite satisfactorily.

FIG. 4.

Showing an incised wound which extends not only through the cornea but also involves the sclera on either side.

A very troublesome type of case is one in which the wound has passed through the limbus on one side across the cornea and through the limbus on the other side (Fig. 4). These cases will

only permit of conservative treatment when the wound is just within the limbus; wounds which pass across the middle of the cornea will cause so much harm that the eye will have to be excised at once.

In those cases which allow an attempt to save the eye, wounds usually pass across the lower part of the cornea, and it will be found that after the prolapsed iris has been removed the edges of the corneal wound do not fall into apposition and that any chance of healing is very

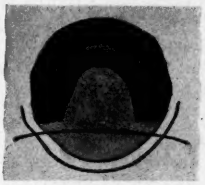

FIG. 5.

Showing the wound freed of uvea and the incision to be made round the cornea so as to detach the conjunctiva.

small and the risk of intraocular infection equally great. Much more is this the case when the prolapse has been present several days and the lower corneal flap accustomed, as it were, to its vicious position.

These wounds must therefore be liberally covered with conjunctiva, with the sutures so placed in the conjunctiva as to help to approximate the edges of the corneal wound. The conjunctiva should be detached from the periphery of the cornea (Fig. 5) in

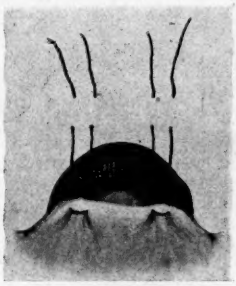

FIG. 6.

Showing the manner of drawing the conjunctiva across to the cornea so as to bury a wound such as that shown in Fig. 5.

about its lower third or even one half and drawn straight across the cornea and sutured at the opposite limbus (Fig. 6). Such sutures will hold from five to seven days and when they have broken loose the conjunctiva will have become firmly adherent to the site of the injury.

A note on the removal of non-magnetic foreign bodies from the anterior chamber

The removal of non-magnetic foreign bodies from the anterior chamber is usually not only very difficult but of extreme danger to the lens. It has been usual when a foreign body is lying on the iris (often in the lower part of the anterior chamber) to make an incision at the limbus with a keratome at the site of the foreign body (Fig. 7) and then introducing a curved iris forceps to try to seize the foreign body and so remove it. This often fails and then an iridectomy is made hoping to include the foreign body in the piece of iris removed.

The reason why it is so difficult or impossible to remove the foreign body in this way is largely due to the fact that the incision at the limbus is not on the same plane as the iris; and therefore not on the same plane as the foreign body; consequently it is not possible in so small a wound sufficiently to depress the points of the forceps used so as to hold the foreign body securely. If the foreign body be at the angle of the anterior chamber

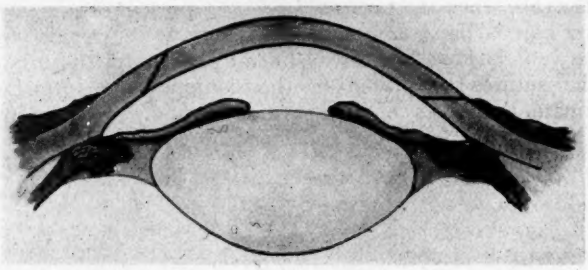

Fig. 7.

To show how it is that the usual incision at the limbus is unsuitable for the removal of a non-magnetic foreign body from the anterior chamber with forceps. If a foreign body be supposed to lie on the iris near the angle of the anterior chamber on the right side of the diagram then with an incision at the limbus the lower lip of the incision will not allow the foreign body to be seized.

If, however, a foreign body be supposed to lie on the iris near the angle of the anterior chamber on the left side of the diagram, it will be seen that the incision indicated over the foreign body affords a much easier approach and an easier field in which to use the forceps.

there is a lip of the sclera between the forceps and the foreign body round which it is not possible to manœuvre the point of the forceps (Fig. 7), and so the attempt must necessarily fail. Again, if the first attempt fails, the iris will in all probability be injured, and blood will cover the field of operation.

The following plan simplifies operation:

Make a keratome incision in the cornea halfway between the centre and the limbus (*i.e.*, three millimetres inside the limbus) in

the quadrant of the cornea lying over the foreign body (Fig. 7) and with the point of the keratome driven towards the foreign body. If the point of the keratome seems to drive too near the angle of the chamber the wound may be enlarged by side-to-side movements instead of by an onward thrust. The foreign body may now be easily seized with toothless iris forceps and withdrawn. The risk of prolapse of iris is also avoided, as with corneal incisions in this situation the iris does not prolapse as is so often the case with incisions at the limbus.

In a case in which an eyelash was lying on the lens and no part lying on the iris a similar procedure was adopted, but the lash was first disengaged and gently coaxed over the iris by a stream of saline solution through the silver nozzle of a M'Keown's irrigator devised for the treatment of immature cataract.

ON A SMALL IMPROVEMENT IN SKIN GRAFTING

BY

ERNEST E. MADDOX

BOURNEMOUTH.

I find the cutting of Thiersch grafts to be facilitated by first painting the skin (after the usual preparation) with a stiffening agent, such as a thin even layer of flexible collodion.

This stiffens the epidermis, so that it moves over the knife with less crumpling, and it also makes the application of the graft much easier in certain difficult situations.

I would not, however, advise the use of a stiffening agent in all cases, since sometimes the very softness of the graft enables it the better to fill in the inequalities of an uneven surface.

Paraffin wax could be substituted for collodion when the latter is not obtainable, but although it would help the cutting, there is the danger of fragments becoming detached and getting in the way during the application of the graft. For this reason collodion or formalized gelatine is better.

ARTIFICIAL EPISTAXIS

BY

ERNEST E. MADDOX

BOURNEMOUTH.

A NOVEL, and I think valuable, expedient came to my rescue as a substitute for Heurtelouping when leeches became scarce during the war. In acute and sub-acute glaucoma and other congestions

and inflammations of the eyes, I have proved that the abstraction of blood from the nasal mucous membrane will often afford speedy relief; while as a preliminary to operations for glaucoma and cataract in haemorrhagic or dangerously plethoric individuals, it is of decided value. Sometimes patients with ophthalmic haemorrhage present also the well-known symptoms which threaten cerebral apoplexy, and then I would advise, and, indeed, have practised, artificial epistaxis, as likely to avert a stroke. Another field of usefulness may be found in the so-called vicarious haemorrhages of the menopause.

Spontaneous nose-bleeding seems to be Nature's favourite mode of relieving congestions of the head, and can we do better than follow her example, and draw blood from the locality she indicates? Such was the consideration which led me to try it. It often happens that persons who have been liable to recurrent epistaxis for years, experience discomfort in the eyes, with the feeling of fulness, after the cessation of the habit. Indeed, we have no doubt all seen vitreous opacities or retinal haemorrhages in some cases of this kind. I well remember, many years ago, receiving the embarrassing petition from a beautiful lady, that I should give her a punch on the nose to make it bleed, as her eyes, she said, were always so much better after attacks of recurrent nose-bleeding, which had now ceased. Unfortunately, at that time I had not conceived this idea of tapping the nasal mucous membrane, and she had to be content with the usual Heurteloup from the temple, as I could not bring myself to her proposition!

It only remains to mention how to effect the little procedure. At first I liked to see what I was doing, and passed a narrow tubular cool electrical lamp into the *opposite* nostril to the one chosen for attack. This turned the nose into a kind of lantern, the cartilaginous septum being semi-transparent, and the best spot for the incision of the mucous membrane could be selected with ease. I soon found it unnecessary, however, to take this trouble, unless the yield of blood without it proved too small. I simply now pass an extremely small keratome up the nostril, keeping its back against the septum, and then, when high enough up, a sudden turn of the wrist does all that is required. I can thoroughly recommend this mode of depletion, and besides its use in suitable cases in ophthalmology, I should not be surprised if physicians might also with advantage borrow the idea for some congestive conditions of the head, especially during the crises of fevers, and invariably, I would suggest, after *cerebral concussion*. A sterilized penknife is nearly always obtainable in the absence of anything better.

COUNCIL OF BRITISH OPHTHALMOLOGISTS

The following report was presented at a general meeting of British Ophthalmic Surgeons, held at the house of the Royal Society of Medicine on April 30, 1920.

The Council of British Ophthalmologists was founded at a meeting held at the house of the Royal Society of Medicine on May 2, 1918. It owed its inception to the need for some body which could act rapidly and authoritatively in regard to any questions of ophthalmological interest arising in connection with national industries or public services. In the past such questions have usually been referred, often in a haphazard manner, to individual ophthalmic surgeons, who could express only their own opinions. Fortunately many of those to whom application was made were well fitted to give advice, but some at least felt that such advice would be of more value if given after the subject had been considered by a council representative of the general body of British ophthalmic surgeons.

During its two years of work the Council has found ample justification for its existence. That the Council has met on nineteen occasions gives but a small idea of the labour involved, since the bulk of the work is undertaken by committees, some of which have held as many as twenty meetings before submitting their reports. These committees consisted of London and Provincial members, and, where it was thought desirable, members, not necessarily ophthalmic surgeons, co-opted on account of special knowledge or experience.

Four reports have been published by the Council:—

I. Standard Illumination of Tests of Visual Acuity.

II. The Need for Improved Training of Medical Students in Ophthalmology.

III. The Need for a Higher Qualification in Ophthalmology.

IV. Vision of Men Engaged in Motor Road Transport.

With regard to the second of these reports the Council regrets that the General Medical Council has not been influenced to take effective action to remedy the deficiences to which the report calls attention. The report (No. III), dealing with the need for a higher qualification, has already exerted a valuable influence.

The Council notes with satisfaction that the general conclusions arrived at in its report on the Vision of Motor Drivers have been adopted by the Police Authorities in London and elsewhere, and have met with acceptance by the leaders of the men concerned.

These reports represent only a part of the work of the Council. Early in its career it nominated representatives to examine and

advise on the records of Grade IV men for the Ministry of National Service. Four members were nominated to serve on a London County Council committee dealing with the lighting of cinemas and eye strain. Committees have been appointed to consider the standardisation of test types and the notation of cylinder axes, and the question of sight-testing by opticians. Two representatives of the Council are serving on the Visual Optics Sub-committee of the Advisory Committee on Technical Optics.

Several subjects of a confidential nature referred to the Council by various public bodies have been dealt with. The expenses of the Council have been defrayed by its members.

ANNOTATIONS

The M.S. in Ophthalmology

As already noted in these columns (1919, p. 430) the University of London has sanctioned the granting of the M.S. degree in two additional branches, one of which is ophthalmology, a fact that can scarcely be too widely known among ophthalmic surgeons. The University's regulations are quoted below in full:

Branch III. Ophthalmology.

Every candidate for the Degree of Master of Surgery (Branch III) must have taken the Degrees of Bachelor of Medicine and Bachelor of Surgery in this University not less than two years previously, except as provided below.

Candidates who have either

(i) taken the M.B., B.S., Degrees with Honours in Surgery;

or (ii) subsequently to taking the M.B., B.S. Degrees, conducted a piece of original work approved by the University;*

or (iii) subsequently to taking the M.B., B.S. Degrees had such exceptional experience as may be approved for this purpose by the University,*

may present themselves after an interval of one year only from the time of taking the M.B., B.S. Degrees, provided that they comply in other respects with the conditions stated in the following paragraphs.

* Applications under this Section must reach the University not later than three months before the first day of the examination.

Certificates.—Every candidate must forward together with his form of entry the following certificates: *

1. A certificate of having spent at least two years in the study and practice of Ophthalmology at a teaching school or schools approved by the University, of which one year at least must have been subsequent to obtaining the M.B., B.S. Degrees in this University.

2. A certificate of having held during this time for at least six months an approved appointment † in the Ophthalmic department of a general hospital recognized by the University for the purpose, or at an Ophthalmic hospital recognized by the University.

Details of Examination.—The examination will consist of:

Two papers in Ophthalmology (in one of which there may be included a case for commentary).

One paper in the Principles of Surgery.

A clinical examination.

One paper in the Anatomy and Physiology of the Eye and other parts concerned in Ophthalmology (including Physiological Optics).

One paper in the Pathology of the Eye and other parts concerned in Ophthalmology.

An oral examination.

Candidates shall not be approved by the examiners unless they have shown a competent knowledge in all the subjects of the examination.

Elliot Ophthalmic School

An event of more than local importance took place recently when Her Excellency Lady Willingdon opened the Elliot Ophthalmic School in connection with the Government Hospital in Madras. This is the outcome of the decision reached by the Government of Madras in 1916 to give theoretical instruction and practical training in ophthalmology side by side in the same building. The Government accordingly sanctioned the construction of a building, at an estimated cost of Rs. 75,750, within the grounds of the Ophthalmic Hospital, and determined to name it after Lieut.-Colonel R. H. Elliot, in recognition of the services rendered by him to ophthalmology in Madras and elsewhere. There is accommodation in the new school for 120 students and graduates, and the tuition will be in the hands of Lieut.-Colonel H. Kirkpatrick and his successors. The section of ophthalmology in the medical college will be

* (Internal regulations only.) Candidates entering for this examination under Statute 129 will also be required to send in a certificate of having completed the prescribed course of study.

†A list of these appointments may be obtained on application to the Academic [or External] Registrar.

transferred to the new school. The building is divided into two floors, of which the first includes a large waiting hall, lecture theatre (fitted with an epidiascope), a dark room for thirty students, and luncheon rooms. The second floor is provided with a large museum, liberally furnished with models, pictures, and stereoscopic views of external diseases of the eye. There are pathological specimens and microscopical slides are also on exhibit. Attached to the museum is a studio with a dark room. A library and a room for practising operations upon dummy eyes are also provided. The silver key used in formally opening the building had inscribed upon it "In tenebras lucem."

The Illumination of Mines

The interesting account of the discussion on the illumination of mines which we were enabled to publish last month by the kindness of the Illuminating Engineering Society, shed considerable light on what expert opinion agreed in considering the best form of lamp. That opinion was largely in favour of the electric lamp. The discussion was, and naturally so, mainly confined to medical men and representatives of lamp makers, and little was said about the opinions of the user of the lamp, the miner himself. Mr. J. George said that in one district in Scotland the miners have the best oil lamp to go down with for nothing, but they prefer to pay 9d. per week and have the electric lamp. If further corroboration of this statement is needed it may be found in a note in the *Electrical Review* for April 9th, p. 466, "Electric Lamps in Mines. As a protest against the non-provision of electric lamps in the mine—which they claim give more safety and a better light below ground —1,400 men employed at the Tirpentwys Colliery, Pontypool, have given a fortnight's notice to cease work." We are indebted to the courtesy of Mr. L. Gaster, the Hon. Secretary of the Illuminating Engineering Society, for the above reference. Although it must be admitted that the miners are only too ready to strike for any cause at the present time, the above statement would certainly show that they approve of the electric lamp.

Cobalt Glass in Refraction Work

The use of cobalt glass as an occasional aid in refraction has been known for many years, and is the subject of casual reference in some text-books. It is usually spoken of as being of great scientific interest but of little practical use; but occasionally in dealing with intelligent patients it proves of great service. Its

value lies mostly in the rapidity with which one can find the axis of astigmatism even of small degrees, and also as a confirmatory test when the full correction has been put up. The principle on which the test is based is the cutting out of all rays between the two extreme ends of the visible spectrum. Not all specimens of cobalt glass do this in a satisfactory manner, but a good cobalt allows only red rays and blue rays to pass through. As the refrangibility of the blue rays is much greater than that of the red rays, they are brought to a focus sooner. In a normal emmetropic eye, where a point of white light placed at distance of 6 metres is focussed on the retina, the red rays will have their focus behind the retina and the blue rays in front of the retina, and the two pencils will intersect in the retina and give a uniformly coloured light with sharp edges. If the eye be myopic a red centre of light will be seen with a blue fringe, and if hypermetropic a blue centre with a red fringe. Hypermetropic astigmatism gives a blue centre with red dots on each side and the inclination of the dots is at right angles to the axis of the astigmatism. In mixed astigmatism the blue extends to a rod with the red on each side and in myopic astigmatism one gets a red centre with blue caps extending from it. The test is only occasionally serviceable, as it is entirely a subjective test, but at times it may save ten or fifteen minutes' work and give a very clear indication as to the nature and degree of error.

ABSTRACTS

I.—REMEDIES

(1) **Gérard, Georges (Lille).—On the curability of trachoma by oxidised naphthol-camphor. (De la curabilité du trachome par le naphtol-camphré oxydé).** *Annal. d'Ocul.*, December, 1919.

(1) **Gérard** has elaborated a technique for trachoma which, after three years' use, he recommends very highly in the present article. He has tried other remedies but gets better results, at least in the acute and exuberant trachomas, with oxidised naphthol-camphor, accompanied by iodine and zinc chloride, than with any other. In 1916 he suggested that trachoma was a local manifestation of tubercle, and finding confirmation of the presence of tuberculous lesions in many of his bad trachoma cases he thought to apply the anti-tuberculous drugs to a disease which he associated with tubercle. With certain precautions, which he has elaborated and illustrated in the present paper, he finds that naphthol-camphor is well tolerated,

is less painful than copper and never leads to corneal lesions. The naphthol-camphor should be freshly prepared but allowed to stand exposed to light and air till it has become oxidised, as evidenced by its syrupy consistence and its catechu or brownish mahogany colour. Two parts of camphor, one part of naphthol warmed gently, then filtered away from the air, are used, then the mixture is left in a clear glass vessel to oxidise.

The special point of his technique is the use of fine old linen in the shape of a small rectangle with a fold across, this folded part being placed under the everted upper lid to protect the cornea. In this way two layers of linen lie in front of the eye; the anterior one can be used to dry the upper lid conjunctiva just before the application is made with a small sable brush well soaked in the solution and then wiped nearly dry before use, while the posterior layer of linen lies against the cornea and protects it. Two or three fairly firm applications from one side to the other, limited to the affected parts of the conjunctiva, are made, then the patient is asked to look up; when he does this the upper lid rights itself and the inner surface of it comes against the front layer of linen, which acts like blotting paper and takes up any excess of the caustic. The linen is kept in place for three to five minutes after the application, by which time any risk of damage to the cornea will have passed away. There is sharp pain for three to four minutes, then a bearable discomfort for another fifteen to thirty minutes, but not much worse than with silver and considerably less than with copper. Six or seven hours later the secondary reaction sets in, indicating the penetration of the drug; this lasts about fifteen to thirty minutes again but does not occur in every case. Some conjunctival congestion is produced. Gérard says the patients come back willingly and regularly for this treatment and feel early the benefits when the case is acute or the granulations exuberant. The application is made by the surgeon, and two or three weekly are enough, over a period of two, three, and sometimes four weeks.

Of Balesi's 38 cases, 17 were definitely cured, while in the more fortunate cases four to ten applications sufficed to give the normal appearance to the upper lid. Some of the chronic cases, however, were helped but not cured, and these seemed to resist all forms of treatment. Hence Gérard claims a curability and not a definite cure every time for his treatment. He emphasizes the necessity of these applications being supplemented by treatment carried out by the patient between the applications. This complementary treatment consists of lukewarm compresses, applied to the eye three to six times a day, of tincture of iodine, 1-2 grammes to 100 of distilled water, and of drops of zinc chloride at night, starting at 5 milligrams to 10 of water and working up to even 20. Where severe watering occurs after the applications of the naphthol-camphor

he sometimes uses hot compresses of zinc sulphate, 0·5 grammes to 100 of water two or three times a day.

W. C. SOUTER.

(2) **Jacovides (Alexandria).—Autoserum in ocular therapeutics in Egypt.** *Ophthal. Soc. of Egypt*, 1919, p. 80.

(2) Rohmer's method of treating certain inflammatory diseases of the eye by injecting beneath the conjunctiva the serum obtained from a blister on the patient's body is recommended by **Jacovides** who has employed it in 221 cases since September, 1914. Most of these (150) were examples of hypopyon keratitis, and of these 140 were cured by two or three injections of serum. Of 51 cases of corneal infection produced by foreign bodies, 30 were cured by two and 21 by one injection of the fluid. A couple of infections after extraction of cataract were cured by four injections, although in one of them an iridectomy was made because the pupil was closed. The author found that the serum from young subjects was remarkably efficacious, whereas that from the old and debilitated had much less power.

S. S.

(3) **Aguizy, Abdel Aziz El (Tanta).—Treatment of infected ulcers of cornea, with recommendations of subconjunctival injections of mercury perchloride.** *Ophthal. Soc. of Egypt*, 1919, p. 85.

(3) **Aguizy** recommends the treatment of infected ulcers of the cornea by the subconjunctival injection of 5 to 10 drops of a solution of sublimate (1:2,000) as near the ulcer as possible, reinforced by the usual means, as heat, atropin, and antiseptics.

S. S.

(4) **St. Martin (Toulouse).—Puncture of the eyeball and subconjunctival injections in the treatment of recent detachments of the retina. (La ponction du globe et injections sous-conjonctivales dans le traitement du décollement rétinienne récent.)** *La Clin. Ophtal.*, January, 1920.

(4) It is curious how individuals when they have had a success in the treatment of retinal detachment proceed to attempt to modify the pessimistic views which have been generally held with regard to the treatment of this disease. **St. Martin's** case has only been two months with the retina re-attached. The case is that of a female butcher, with one eye already blind from an old detachment, who came to the author immediately after the onset of detachment in the other eye. She was myopic about 8D., and presented, as afterwards ascertained, some peripheral choroido-retinal changes. The detachment occurred as the result of strain

at her work. The treatment consisted in immediate puncture at the site of the detachment (above), subconjunctival injections of salted gelatinized serum, rest in bed, and a pressure bandage. Atropin. Mercury internally was also exhibited. The author insists, contrary to the advice of Deutschmann, that in recent cases immediate puncture should be performed at the site of the detachment, thus not waiting for a superior detachment to become inferior.

ERNEST THOMSON.

(5) **Dor, L. (Lyon).—Cyanide of gold and cantharidine (Krysolgan) in tuberculous affections of the eye. (Le cyanure d'or et de cantharidine (Krysolgan) dans les affections tuberculeuses de l'oeil.)** *La Clin. Ophtal.*, December, 1919.

(5) Krysolgan is a new salt of gold which is offered as a specific for tuberculous affections. It is a monocyanide of gold-ethylene-diamine-cantharidine, and contains 50 per cent. of gold. This article by **Dor** is a short review of the work done by others with this new drug. The references are as follows:—Feldt, *Berliner Klinische Wochenschrift*, 1917, No. 46 and 1918, No. 10; Schnaudigel, *Klinische Monatsblätter für Augenheilkunde*, 1917, Sept.-Oct.; Hessburg, *Zeitschrift für Augenheilkunde*, Vol. XL, fasc. 6, page 324. According to Schnaudigel, this drug is undoubtedly a specific in tuberculous disease of the eye. Its action is comparable to that of tuberculin, and cases of chronic uveitis are those which are most favourably influenced.

ERNEST THOMSON.

II.—MISCELLANEOUS

(1) **Rochon-Duvigneaud, A. (Paris).—Ophthalmological reform. (La réforme ophtalmologique.)** *Ann. d'Oculistique*, T. CLIV, January, 1917.

(1) In this essay, extending to eleven pages, **Rochon-Duvigneaud** takes occasion to point out some of the directions in which the position of the science and art of ophthalmology might be improved after the war. His main contention is for a much-needed increased collaboration between the teachers of physical optics, physiological optics, ocular physiology, special anatomy, and ophthalmology generally, each of which subjects seems to be at present worked out along its own lines without any reference to the others. Further, he asks that some place should be established—say, on the lines of the Pasteur Institute—to which one could repair for

the purpose of elucidating or having elucidated any of the many problems that arise daily in ophthalmic work. As subjects for special study, he mentions intra-ocular pressure, corneal absorption, corneal grafts, and comparative anatomy and physiology.

His other main point is the dual one, that many men hold teaching posts who are not suited to the work of teaching, but are suited more for laboratory or for clinical work, while many of those who would like to devote time either to teaching or to laboratory work, are unable for financial reasons to do so, but must curtail their hospital and teaching work to allow themselves time for work which is more directly remunerative.

Rochon-Duvigneaud is not without hope that the State, ever parsimonious in the matter of endowments for scientific work, may be induced to endow adequately those whose faculties and inclinations indicate that they should adopt teaching or laboratory work to the more or less complete exclusion of private practice. The actual precise detailed individual teaching, which is so necessary, is compatible neither with a large clinic nor with the penury of the majority of hospital laboratories. He pleads for the retention of the smaller free clinics, which have done so much good by their healthy initiative, in spite of the opposition of the great charities. He regrets, with Parinaud, that although so much in the study of vision has been done by physicists and mathematicians, so little has been done by biologists and physiologists.

He hopes to elicit discussion to bring out the necessarily diverse points of view of other workers.

W. C. SOUTER.

(2) **Thomson, Alexis (Edinburgh).—The grafting or transplantation of tissues.** *Edinburgh Medical Journal*, March 1917.

(2) This lecture on the transplantation of tissues, by **Thomson**, appeals but indirectly to the ophthalmic surgeon, although the subject is obviously of no little importance to the general surgeon. The best prospect of success is by the transference of a portion of tissue from one part of the body to another part of the same animal, *autoplasty*. Next comes *homoplasty*, that is, the transference of tissues from one animal to another of the same species. *Heteroplasty*, the transference of tissue from one species of animal to another, is the method least likely to succeed. It has been suggested that all protoplasm is specific for each organism and varies with the individual (Ullman).

Certain surgical details making for success include careful handling of the graft, absolute contact between graft and soil, and the exclusion of all infection. Of all the tissues, the blood and the epidermis can be transferred with the greatest likelihood of success.

The whole thickness of the skin may be employed to cover a raw surface, and if successful, it yields a stronger and more enduring covering than is obtained from epidermis alone. Whenever feasible, a *two-stage method* is employed in the transplantation of a completely detached flap of skin, as in the Italian operation for the restoration of an eyelid. In all methods it is essential that the flap be cut generously, and a rough guide is to cut the flap about one-third larger than the gap it is destined to fill. It must not, of course, be subjected to the slightest tension or to undue pressure. Transplantation of the mucous membrane follows that of skin in most of its details, but the difficulty of securing asepsis is a serious handicap. Success, however, has attended the formation of a new eyelid from the tissues of the lip. We need scarcely follow the author into his discussion of the transplantation of blood-vessels, bones, teeth, nerve tissue, tendons, and the like.

S. S.

BOOK NOTICES

Abstract-Bulletin of Nela Research Laboratory. National Lamp Works of General Electric Company, Cleveland, Ohio. EDWARD P. HYDE, Director. 1919.

This is the second number of the first volume of Abstracts of Papers published from this Laboratory.

One cannot speak too highly of the work done in this institution, and it seems a great pity that such a good example is not followed in this country in connection with various industrial undertakings.

The volume contains abstracts of thirty-four papers, most of which are purely physical. Abstracts of a few given below have a direct bearing on ophthalmology. The others should be studied by those who are interested in the physical side of the subject.

Paper 61—"The Injurious Effect of Ultra-violet Radiation on Living Tissue." By W. E. BURGE.

It has been recognized for some time that the radiation from a quartz mercury arc, or from an iron arc, or from any light-source emitting large quantities of ultra-violet rays is harmful to the eye. It may be assumed that wave-lengths shorter than 350 $\mu\mu$ are injurious to living tissues. The object of the investigation is to determine the wave-lengths in the ultra-violet region of the spectrum which are injurious and their mode of action in producing the injury. The following experiments were made to determine the mode of action of ultra-violet radiation in coagulating or rendering insoluble the proteins of egg white and of the crystalline lens.

Action on Proteins of Egg White

Films of egg white were made and exposed for 30 hours to the action of the quartz lamp, part being exposed and part being covered by cardboard. They were then placed in a 1 per cent. solution of calcium chloride, and the portion of the egg white which had been exposed to the action of the quartz lamp was coagulated, whereas the unexposed portion remained unaffected.

Action on Proteins of Crystalline Lens

Similar films of lens substance made from pigs' lenses were exposed at the same time with the same result.

Action of different Wave-lengths in the Ultra-violet Region of the Spectrum

An extract of pig lenses was made with a 1 per cent. calcium chloride solution and placed in a circular quartz cell made of two quartz discs having between them a hard rubber ring. By means of a small quartz spectrograph the radiation from a quartz mercury vapour burner was focussed on the lens extract in the quartz cell. A coagulated line of lens protein, where the spectral line of wave-length 254 $\mu\mu$ was focussed, appeared after 50 minutes' exposure; one where the spectral line of wave-length 265 $\mu\mu$ was focussed appeared after 65 minutes' exposure; one where 280 $\mu\mu$ and 302 $\mu\mu$ were focussed appeared after 120 minutes' exposure. The remaining lines of coagulated lens extract appeared after 200 minutes' exposure. By covering half the slit of the spectrograph with the cornea of a rabbit it was shown that the cornea transmits wave-lengths as short as 297 $\mu\mu$ and 302 $\mu\mu$, and that these wave-lengths are effective in changing the protein of the lens so that calcium salts can combine with it to form a coagulum, as just shown. A photograph of the spectrum made through a layer of the lens extract 1 mm. thick shows that the extract absorbs all wave-lengths shorter than 313 $\mu\mu$, and that all of these absorbed short wave-lengths are effective in coagulating the protein of the lens extracted with 0.1 per cent. calcium-chloride solution. A layer of aqueous humour 1 mm. thick did not absorb these effective wave-lengths appreciably.

The Production of Anterior Eye Trouble in Living Animals by means of Ultra-Violet Radiation

Frogs were kept in 0.2 per cent. sodium silicate, 0.8 calcium chloride and another batch in tap water for 15 days, then exposed on five successive days to the radiation from a quartz mercury lamp for one hour. On the 15th day in the frogs living in the sodium silicate and calcium chloride the eyelids had become converted into an opaque mass, but the frog living in tap water was very little

injured. It is well known that the skin sunburns more quickly when wet than when dry, and it is probable that this is due to the moisture allowing the calcium to combine more freely with the proteins of the cells.

The Production of Cataract in Living Animals by means of Ultra-Violet Radiation

It is known that cataractous lenses obtained from India contained distinct amounts of the silicates of potassium, calcium and possibly of sodium, while those from the United States contained no silicon. The experiments were conducted on fish, and to increase the amount of calcium contents of the body, goldfish were kept in calcium chloride, calcium nitrate, and sodium silicate, and also in tap water for ten days. At the end of this time their eyes were exposed in a quartz bottle to the action of a quartz mercury vapour lamp. It was found that in the fish in the salt solution the cornea and lens became opaque, but by transferring the fish back to ordinary water the cornea cleared, whilst the lens remained cataractous. The fish in ordinary tap water was unaffected.

A photograph of the spectrum, taken through the cornea of a rabbit, shows that the cornea transmits wave-lengths up to 302 $\mu\mu$, which from the foregoing experiments are seen to be effective in coagulating lens proteins. It is therefore clear that the protective action of the cornea is not complete and that the coagulation of the lens proteins depends on the presence of calcium or silicate in the tissue. It has been shown that the normal lens contains 0.08 per cent. of calcium in the ash, whilst a cataractous lens contains 15 per cent.

Glass-blowers' Cataract

The eyes of glass-blowers are probably subject to more of the short waves of the spectrum than the eyes of people generally. It may be assumed that these short waves modify the protein of the lens so that if abnormal amounts of the salts of calcium or silicates are present these combine with the modified lens protein to precipitate it, and hence produce an opacity of the lens. It must be assumed that those who do develop cataract have a more or less disturbed condition of nutrition expressing itself in an increase of those substances which can combine with the lens protein, modified by ultra-violet radiation, to precipitate it.

Paper 62.—"Glasses for Protecting the Eyes in Industrial Processes." By M. LUCKIESH.

The destructive effect of ultra-violet radiation is well known, but the wave-length limits of the destructive spectral region are not

definitely known. It is a matter of common knowledge that ordinary clear glass reduces the deleterious effects on the eye from the radiant energy of bare iron and carbon arcs and the quartz mercury lamp. Many industrial processes require the use of these rays. Infra-red energy, as far as it is known, does not cause cataract unless it is used in excessive amounts so as to produce an actual burn. Various types of glasses were used for the transmission of ultra-violet radiation through a quartz spectrograph. In obtaining the transmission-curves a photographic method of photometry was used. It was found that yellow green glasses were the most serviceable for all purposes. An interesting point in the case of amber glasses is that in the lap-welding department of a steel mill, where the temperature is judged by visual observation, the operators could not do so with amber glasses, but experienced no difficulty with yellow-green glasses.

Paper 60.—"Radiant Energy and the Eye." By M. LUCKIESH.

Not all the radiant energy which enters the eye is active in producing the sensation of light, and it is fair to assume that the "inactive" energy is absorbent and transformed into heat. There is a general feeling that artificial light is more fatiguing than daylight, which contains less energy per lumen-second than the light from ordinary artificial illuminants. As a matter of fact, it is usually ignored that daylight illumination intensities are often hundreds or even thousands of times greater than ordinary artificial illumination intensities, and that artificial light is usually used during the latter part of the day's activities. Computational method was used, the various eye media being represented by thicknesses of water.

TABLE I.

THICKNESSES OF WATER CORRESPONDING TO VARIOUS EYE MEDIA

	Centimeters of Water.	Total Depth to Posterior Surface.
Cornea	0·06	0·06
Aqueous humor	0·34	0·40
Crystalline lens	0·42	0·82
Vitreous humor	1·46	2·28
Total depth of eye	2·28	2·28

Black body illuminants were used.

TABLE II.

ABSORPTION IN WATTS PER LUMEN

Source.	Watts per Lumen absorbed in							
	Water of Depth.				Cornea.	Aq. humor.	Lens.	Vit. humor.
	0·06cm.	0·4cm.	0·82cm.	2·28cm.				
Black body at 2,000 absolute	0·153	0·179	0·186	0·20	0·153	0·026	0·007	0·013
,, 2,500 ,,	·04	·049	·053	0·061	·04	·009	·004	·008
,, 3,000 ,,	·012	·0156	·0174	·0202	·012	·0036	·0018	·0028
,, 4,000 ,,	·0035	·0049	·0057	·0071	·0035	·0014	·0008	·0014
,, 5,000 ,,	·0015	·0023	·0027	·0035	·0015	·0008	·0004	·0008
4-w.p.c. treated carbon lamp	·247	·297	·312	·338	·247	·05	·0015	·026
1.25-w.p.c. tungsten lamp	0·064	0·082	0·089	0·101	0·064	0·018	0·007	0·012

Paper 59.—"Visual Pattern-discrimination in the Vertebrates." By H. M. JOHNSON.

The animal was put into an experimental box in which there are two food compartments, and one door of the food compartment is marked with the pattern. If the animal gets into the wrong box he receives an electric shock, but if he gets into the right box he receives his food. The pattern to be discriminated is placed upon the one containing the food. The animal is previously fed in both compartments, so that there should be no reason why he should go into one compartment more than the other except that it is marked with the pattern.

Conclusions

The capuchin monkey possesses a visual acuity and a sensitivity to difference in size of visual detail of the same order as those of mankind. He is also quite sensitive to difference in direction of the elements of a simple pattern, but his threshold for this characteristic difference is higher than the human threshold.

The visual acuity of the chicken is only 20 to 25 per cent. as good as that of the monkey and man; and the chick's sensitivity to differences in size and direction is only 8-12 per cent. as good as that of the monkey.

The dog is relatively insensitive to detail in visual objects, and the deficiency is retinal.

The most obvious structural difference among these types of eyes is the degree of retinal development. While other factors were doubtless more or less effective, the difference in retinal structure is

a sufficient explanation of the difference in visual sensitivity. It is to be hoped that future and more intensive experiments will show to what extent the various differential factors were operative.

In so far as evolutionary theories attribute detail-vision to animals having a retinal structure, of which the dog's is typical, they would seem to require modification.

In addition to these papers, there are several other interesting papers which are more of a physical nature such as:

"The Effect on Foveal Vision of Bright Surroundings."

"The Influence of Pupillary Diameter on Visual Acuity."

"Visual Acuity in White Light."

"The Shortest Perceptible Time Interval between Two Flashes of Light."

"Experiments of Color-Saturation."

"On the Growth and Decay of Color Sensations in Flicker Photometry."

M. S. M.

Sight-Testing Made Easy. By W. M. HARDWICKE, M.D. London: J. & A. Churchill, 1920. 4th Edition, price 5s.

The production of a fourth edition indicates a definite demand for a book of this type. The information given should be superfluous to any one who has had ophthalmic trainjng. Others who have not had such training will not be enabled to make good their deficiencies and do refraction work with benefit to their patients by reading such a book.

The author states on page 20 that "In hypermetropes the ciliary muscle becomes hypertrophied owing to its excessive use, thus overcrowding the ciliary region, with the consequence that glaucoma is most common in hypermetropic eyes"; and again on page 22, "Myopes, however, enjoy an almost complete immunity from glaucoma because of the atrophy of the ciliary muscle due to the comparative lack of its use." Neither statement will meet with general acceptance. In discussing the use of cycloplegics he says that atropin should never be used for patients over thirty-five years (page 46). Again, in dealing with squint on page 39, "If after seven years of age, but not before glasses have been worn for some months, and no improvement is manifested, operative interference will be necessary."

E. E. H.

NOTES

Deaths

THE death has taken place of Herbert Danvers, M.D. (Paris), at Nice. He formerly practised in London, and in 1901 wrote a small book on "Spring Catarrh of the Eyes." The deaths are

announced of Jules-Emeric Arens, of Antwerp, who was director of the Army Ophthalmic Institute at Louvain, and of F. Marzorati, once assistant to Professor Gallemaerts at the Saint Jean Hospital, Brussels.

* * *

Appointments

Lieut.-Colonel R. H. Elliot has been appointed ophthalmic surgeon, and N. B. B. Fleming assistant ophthalmic surgeon to the Prince of Wales General Hospital, Tottenham, N. T. L. de Courcy has been appointed ophthalmic surgeon to the Royal Southern Hospital, Liverpool. At a recent meeting of the Governors of the Gloucestershire Royal Infirmary and Eye Institution at Gloucester, E. Dykes Bower, who has served the institution as ophthalmic surgeon for thirty-eight years, was appointed consulting ophthalmic surgeon. On the invitation of the Governors, Mr. Bower continued his active services during the war. Lieut.-Colonel H. B. B. Cunningham, attached to the Army of the Rhine, has been appointed a member of the consulting staff of the Ulster Hospital for Women and Children.

* * *

Montgomery Lectureship

Professor Grafton Elliot Smith has been elected to the Mary Louisa Prentice Montgomery Lectureship in Ophthalmology. His first lecture will be given in October next and will be entitled "The Influence of Stereoscopic Vision on the Evolution of Man."

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Miners' Nystagmus

THE subject of miners' nystagmus is evidently not to be allowed to rest. It was recently raised in Parliament when Major Baird, Parliamentary Under-Secretary to the Home Office, stated, in answer to questions by Mr. Swan, that in 1914 (the last year for which figures were available) compensation for nystagmus was given in 5,992 cases, a total made up of 3,218 cases continued from other years, and 2,774 new cases. In connection with the departmental committee which had been sitting since May last, researches were being conducted at the Home Office experimental stations at Eskmeals and elsewhere. The importance of a good light was fully recognized, and a series of trials were on the point of being made with lamps capable of yielding such a light, but the Government could not take legislative steps while the enquiry was still in progress.

* * *

Middlemore Prize

THE Council of the British Medical Association has decided that the Middlemore Prize shall be awarded this year for the best Essay on "Perimetry (inclusive of Scotometry): its Methods and its Value to the Ophthalmic Surgeon."